# TITLE OF THE INVENTION

# CATHODE RAY TUBE WITH TENSION MASK

## CLAIM OF PRIORITY

**[0001]** This application makes reference to, incorporates the same herein, and claims all benefits accruing under 35 U.S.C. §119 from an application for *CATHODE RAY TUBE HAVING A TENSIONED MASK* earlier filed in the Korean Industrial Property Office on 27 March 2001 and there duly assigned Serial No. 2001-15951.

## BACKGROUND OF THE INVENTION

### Field of the Invention

**[0002]** The present invention relates to a cathode ray tube and, more particularly, to a cathode ray tube which has a color selection apparatus bearing a tension mask.

### Description of the Related Art

**[0003]** A cathode ray tube, the most popular display device, has been developed in various formats while keeping pace with the times. Recently, a wide screen cathode ray tube has been the choice of electronic consumers.

**[0004]** In order to enlarge the screen size, the screen panel should be flat in consideration of the quality of the screen images displayed at the periphery of the screen.

**[0005]** As the panel becomes enlarged and flattened, a shadow mask for the color selection apparatus is also enlarged in size. In consideration of various difficulties related to the enlargement of the curved shadow mask such as a weak strength thereof, a new-modeled color selection apparatus has been now employed for use in the cathode ray tube.

**[0006]** Such a color selection apparatus has a structure where a mask with a plurality of beam-guide holes is not curved but flattened while bearing a predetermined tension. For instance, U.S. Patent No. 5,111,107 by Kume et al. for *Grid Apparatus for a Color Cathode Ray Tube which Eliminates Vibration of the Grids* discloses a grid apparatus bearing such a structure.

**[0007]** The grid apparatus has a plurality of slender and long grid members fitted to a frame while being tensioned in the longitudinal direction (X-axis direction). The frame has a pair of support bars arranged parallel to each other while bearing a predetermined distance between them and connected to the grid members, and elastic members attached to the ends of the support bars while being positioned between them.

**[0008]** The grid apparatus further has metallic members attached to the elastic members while bearing a thermal expansion coefficient greater than that of the latter. The metallic members prevent the grid members from suffering thermal deformation during the heat treatment process.

**[0009]** Meanwhile, a plurality of phosphors are formed at the internal surface of the panel in the X-axis direction (in the direction of the short axis of the panel) while corresponding to the pattern of beam-guide holes formed by the grid members. A black matrix is formed between the neighboring phosphors.

**[0010]** However, in the above-structured cathode ray tube, when the plurality of phosphors are arranged in the above-described manner to form a phosphor screen, mis-landing of the electron beams is liable to occur at the periphery of the screen while causing deterioration in picture quality due to the color spots.

**[0011]** The electron beams should correctly land on the phosphors at the periphery of the screen under the influence of the vertical magnetic field component of the terrestrial magnetism. However, with the above structure, the electron beams move in the direction vertical to the X-axis direction (the direction of Y-axis), and land on the incorrect phosphors.

**[0012]** In order to solve such a problem, it has been suggested that the phosphors should be arranged in the direction of the long axis of the panel (or in the horizontal direction). For instance, such a cathode ray tube is disclosed at Korean Patent Publication No. 91-10602 by Yim et al. for *Color Cathode Ray Tube*, U.S. Patent No. 5,099,169 by Vriens for *Shadow Mask Color Display Tube*, U.S. Patent No. 5,170,102 by Sluyterman et al. for *Picture Display Device* and 5,889,362 by Barten for *Color Display Tube having a Reduced Deflection Defocusing*.

**[0013]** However, the above Patents are only related to a usual cathode ray tube bearing no tension mask.

**[0014]** In order to prevent mis-landing of the electron beams with the cathode ray tube bearing a tension mask, various conditions such as the arrangement pattern of phosphors, the tensioned state of the shadow mask and the shape of the panel should be satisfied in an appropriate manner. In this way, the resulting flat cathode ray tube can bear good picture quality.

**[0022]** According to another aspect of the present invention, the cathode ray tube includes a panel with a substantially flat outer surface and an inner curved surface. The inner curved surface of the panel has a phosphor screen. A funnel is connected to the panel while externally mounting a deflection unit for deflecting electron beams. A neck is connected to the funnel while internally mounting an electron gun for emitting the electron beams. A color selection apparatus is internally fitted to the panel such that the electron beams land on correct phosphors of the phosphor screen. The panel has an effective screen with short and long axis. The panel bears a first thickness Th at the ends of the effective screen in the long axis direction, and a second thickness Tv at the ends of the effective screen in the short axis direction. The second thickness Tv of the panel is established to be larger than the first thickness Th of the panel. The color selection apparatus has a mask with short and long axis while bearing a plurality of beam-guide holes, and a frame combined with the mask such that the mask keeps to being in a tensioned state. The mask is tensioned in the long axis direction while being supported by the frame.

**[0023]** The panel has a third thickness Tc at the center of the effective screen while satisfying the following condition: $V/H \geq 1.1$ where V(%) is $(Tv/Tc)\times 100$, and H(%) is $(Th/Tc)\times 100$.

**[0024]** According to still another aspect of the present invention, the cathode ray tube includes a panel with a substantially flat outer surface and an inner curved surface. The inner curved surface of the panel has a phosphor screen. A funnel is connected to the panel while externally mounting a deflection unit for deflecting electron beams. A neck is connected to the funnel while internally mounting an electron gun for emitting the electron beams. A color selection apparatus is internally

fitted to the panel such that the electron beams land on correct phosphors of the phosphor screen. The phosphor screen is shaped with short and long axis, and the phosphors are longitudinally arranged at the phosphor screen in the long axis direction. The color selection apparatus has a mask with a plurality of beam-guide holes corresponding to the phosphors, and a frame combined with the mask such that the mask is kept to be tensioned in the long axis direction. The electron beams emitted from the electron gun are directed toward the phosphor screen in line while being parallel to the short axis of the phosphor screen.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0025]** A more complete appreciation of the invention, and many of the attendant advantages thereof, will be readily apparent as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings in which like reference symbols indicate the same or the similar components, wherein:

**[0026]** Fig. 1 is a partial sectional view of a cathode ray tube with a color selection apparatus according to a preferred embodiment of the present invention;

**[0027]** Fig. 2 illustrates the pattern of a phosphor screen for the cathode ray tube shown in Fig. 1;

**[0028]** Fig. 3 is an amplified perspective view of the color selection apparatus shown in Fig. 1;

**[0029]** Figs. 4 and 5 illustrate the available patterns of beam-guide holes of a mask for the cathode ray tube shown in Fig. 1;

[0030] Fig. 6 is a schematic view of an electron gun for the cathode ray tube shown in Fig. 1;

[0031] Fig. 7 is a cross sectional view of a panel for the cathode ray tube shown in Fig. 1 taken along the long axis thereof;

[0032] Fig. 8 is a cross sectional view of a panel for the cathode ray tube shown in Fig. 1 taken along the short axis thereof;

[0033] Fig. 9 is a cross sectional view of a panel for the cathode ray tube shown in Fig. 1 taken along the diagonal axis thereof;

[0034] Fig. 10 is a graph illustrating the stress distribution, and the horizontal and vertical wedge rates of a panel for the cathode ray tube shown in Fig. 1;

[0035] Fig. 11 is a perspective view of a color selection apparatus for a cathode ray tube according to a related art; and

[0036] Fig. 12 illustrates the pattern of a phosphor screen for the cathode ray tube shown in Fig. 11.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0037] Preferred embodiments of this invention will be explained with reference to the accompanying drawings.

[0038] As shown in Fig. 11, the grid apparatus has a plurality of slender and long grid members 1 fitted to a frame 3 while being tensioned in the longitudinal direction (in the direction of X indicated in the drawing). The frame 3 has a pair of support bars 3a and 3b arranged parallel to each

other while bearing a predetermined distance between them and connected to the grid members 1, and elastic members 3c and 3d attached to the ends of the support bars 3a and 3b while being positioned between them.

**[0039]** The grid apparatus further has metallic members 5 and 7 attached to the elastic members 3c and 3d while bearing a thermal expansion coefficient greater than that of the latter. The metallic members 5 and 7 prevent the grid members 1 from suffering thermal deformation during the heat treatment process.

**[0040]** Meanwhile, as shown in Fig. 12, a plurality of phosphors 11R, 11G and 11B are formed at the internal surface of the panel in the X direction (in the direction of the short axis of the panel) while corresponding to the pattern of beam-guide holes formed by the grid members 1. A black matrix 13 is formed between the neighboring phosphors 11R and 11G, 11G and 11B, and 11R and 11B.

**[0041]** However, in the above-structured cathode ray tube, when the plurality of phosphors are arranged in the above-described manner to form a phosphor screen, mis-landing of the electron beams is liable to occur at the periphery of the screen while causing deterioration in picture quality due to the color spots.

**[0042]** The electron beams should correctly land on the phosphors 11R, 11G and 11B at the periphery of the screen under the influence of the vertical magnetic field component of the terrestrial magnetism. However, with the above structure, the electron beams move in the direction vertical to the X direction (the direction of Y indicated in the drawing), and land on the incorrect phosphors as

indicated in the drawing by the dotted line.

**[0043]** Fig. 1 is a partial sectional perspective view of a cathode ray tube with a color selection apparatus according to a preferred embodiment of the present invention.

**[0044]** The cathode ray tube includes a panel 24 with an inner phosphor screen 22, a funnel 28 connected to the panel 24 while externally mounting a deflection unit 26, and a neck 32 connected to the funnel 28 while internally mounting an electron gun 30. The electron gun 30 emits a plurality of RGB (red, green, blue) electron beams such that they land on the phosphor screen 22.

**[0045]** The panel 24 has a flat outer surface and a curved inner surface. A color selection apparatus 34 is mounted within the panel 24 to make the desired color selection function with respect to the electron beams.

**[0046]** The panel 24 is substantially rectangular-shaped such that it bears a long axis (indicated in the drawing by the X-X line), and a short axis (indicated by the Y-Y line). The phosphor screen 22 bears the same outline as the panel 24.

**[0047]** As shown in Fig. 2, the phosphor screen 22 includes R (red) ,G (green) ,B (blue) phosphors 22a, 22b and 22c spaced apart from each other with a predetermined distance, and a black matrix 22d disposed between the neighboring phosphors. The R, G, B phosphors 22a, 22b and 22c are longitudinally arranged at the inner surface of the panel 24 in the long axis (X-X) direction (or in the horizontal direction). The black matrix 22d also proceeds longitudinally in the long axis direction.

**[0048]** Fig. 3 is an enlarged perspective view of the color selection apparatus 34. As shown in Fig. 3, the color selection apparatus 34 has a rectangular-shaped mask 36 with a long axis (indicated

by the X'-X' line) and a short axis (indicated by the Y'-Y' line), and a frame 38. The mask 36 is fitted to the frame 38 while being tensioned in the X'-X' direction (or in the horizontal direction).

**[0049]** The frame 38 has a pair of supporting members 38a and 38b as well as a pair of elastic members 38c and 38d. The supporting members 38a and 38b are formed in the shape of a capital letter L while bearing a curved surface contacting the mask 36 such that the mask 36 can bear a curvature corresponding to the inner curvature of the panel 24. The elastic members 38c and 38d are formed in the shape of a capital letter U. The shape of the supporting members 38a and 38b as well as the elastic members 38c and 38d may be varied while making other necessary variations.

**[0050]** In the fabrication process of the color selection apparatus, the supporting members 38a and 38b are arranged in parallel such that they are spaced apart from each other with a predetermined distance, and the elastic members 38c and 38d are welded to the same-sided ends of the supporting members 38a and 38b, respectively. The mask 36 is mounted onto the supporting members 38a and 38b such that it is tensioned in the X'-X' direction.

**[0051]** The mask 36 is formed with a thin metal plate bearing a thickness of 0.1 mm or more. As shown in the drawing, the mask 36 is formed with a plurality of strips 36a spaced apart from each other with a predetermined distance, and a plurality of beam-guide holes 36b disposed between the neighboring strips 36a with a predetermined pitch.

**[0052]** The strips 36a are arranged in the X'-X' direction, and real bridges 36c are disposed between the beam-guide holes 36b in the X'-X' direction while interconnecting them. The beam-guide hole 36b is formed with a rectangular-shaped slot.

**[0053]** The mask 36 is tensioned in the X'-X' direction, and the beam-guide hole 36b is elongated in that direction such that the mask pattern is adapted to the pattern of the phosphor screen 22. It is preferable that the tensional strength of the mask 36 at the periphery thereof should be established to be higher than at the center thereof.

**[0054]** The beam-guide hole 36b of the mask 36 may be differentiated in shape. For instance, as shown in Fig. 4, the beam-guide hole 40a of the mask 40 may be a single slot placed between the neighboring strips 40b while being elongated in the X'-X' direction.

**[0055]** Furthermore, as shown in Fig. 5, it is possible that the beam-guide hole 42a of the mask 42 has the same shape as the above-identified beam-guide hole 36b, and dummy bridges 42c are formed within the beam-guide hole 42a while being extended from the strips 42b in a body.

**[0056]** In the above structure, when the R, G, B electron beams land on the relevant phosphors 22a, 22b and 22c at the periphery of the phosphor screen 22 via the color selection apparatus, possible mis-landing of the electron beams due to the terrestrial magnetism can be prevented in an effective manner.

**[0057]** In operation, the electron beams landing on the periphery of the phosphor screen 22 are influenced by the vertical magnetic field component of the terrestrial magnetism, and displaced from the correct landing positions in the long axis direction (or in the horizontal direction). Nevertheless, as the phosphors of the same color are patterned at the phosphor screen 22 in the long axis direction, the displaced electron beams strike the phosphors of the relevant colors, and do not induce any significant problem in the picture quality.

**[0058]** Of course, the electron beams are also influenced by the horizontal magnetic field component of the terrestrial magnetism so that they are displaced from their correct landing positions in the short axis direction. However, the horizontal magnetic field component of the terrestrial magnetism may be disregarded compared to the vertical magnetic field thereof so that it does not affect the vertical displacement of the electron beams in any significant manner. Even though the vertical displacement of the electron beams is made at some degree, the displaced electron beams land on the black matrix 22d disposed between the neighboring phosphors in the vertical direction while not hitting the undesired phosphors.

**[0059]** It was confirmed through several experiments that with the inventive cathode ray tube, the mis-landing of the electron beams on the periphery of the phosphor screen was reduced by 25% compared to the conventional cathode ray tube.

**[0060]** Furthermore, the electron gun 30 may be structured so that the electron beams thereof are directed toward the phosphor screen in line while being parallel to the short axis of the phosphor screen. For that purpose, as shown in Fig. 6, cathodes 30a, 30b and 30c coated with electron beam emission materials are arranged in line while not being parallel to the long axis direction, but being parallel to the short axis direction, thereby forming the plurality of electron beams. Of course, other components of the electron gun 30 should be controlled in an appropriate manner.

**[0061]** Meanwhile, as the cathode ray tube is formed with a completely flattened panel 24, it is liable to suffer from an explosion depending upon the distribution of the stresses applied to the panel 24. Furthermore, such a cathode ray tube may involve increase in weight while making an

inconvenience in carriage. In order to avoid such problems, the panel 24 is structured to be well adapted to the structure of the phosphor screen 22 and the color selection apparatus 34.

**[0062]** The panel 24 bears arbitrary thickness distribution in various directions. Fig. 7 illustrates the thickness distribution of the panel in the long axis direction. Fig. 8 illustrates the thickness distribution in the short axis direction. Fig. 9 illustrates the thickness distribution in the diagonal direction.

**[0063]** As shown in the drawings, the panel 24 bears an effective screen area where the phosphor screen is positioned. The panel 24 has a first thickness Tc at the center of the effective screen, a second thickness Th at the horizontal ends of the effective screen, a third thickness Tv at the vertical ends of the effective screen, and a fourth thickness Td at the diagonal ends of the effective screen. The aspect ratio of the effective screen is established to be 4:3, and the diagonal length D thereof to be 23 inches or less.

**[0064]** The third thickness Tv of the panel 24 is established to be larger than the second thickness Th thereof while satisfying the following condition: $V/H \geq 1.1$ where V (%) is $(Tv/Tc)\times 100$, and H (%) is $(Th/Tc)\times 100$. The value of V or H will be called the "wedge rate." This condition is made such that the degree of stress applied to the panel 24 is reduced while preventing explosion of the cathode ray tube.

**[0065]** Table 1 lists the results of comparing the panel bearing the above condition and the conventional panel.

**[0066]** Table 1

| | Direction of tension application to mask | Central thickness of panel (Tc) | Wedge rate | | | Stress (Long side of panel) |
|---|---|---|---|---|---|---|
| | | | H | V | D | |
| Comparative Example | Short axis | 13.5 mm | 123% | 100.5% | 122.2% | 84.3 kgf/cm$^2$ |
| Example 1 | Long axis | 13.5 mm | 100.5% | 100.6% | 123% | 89.2 kgf/cm$^2$ |
| Example 2 | Long axis | 13.5 mm | 100.5% | 110.2% | 123% | 76.5 kgf/cm$^2$ |
| Example 3 | Long axis | 13.5 mm | 100.5% | 123% | 123% | 66.5 kgf/cm$^2$ |
| Example 4 | Long axis | 13.5 | 100.5% | 150% | 147% | 58.3 kgf/cm$^2$ |

**[0067]** In the Comparative Example, the tension was applied to the mask in the short axis direction, the value of V/H was 0.82, and the stress applied to the long side of the panel was 84.3 kgf/cm$^2$.

**[0068]** By contrast, in the Example 1 where the value of V/H was 1.001, the stress of 89.2 kgf/cm$^2$ was applied to the long side of the panel, and this stress value is too great to obtain the stability of the panel.

**[0069]** In the Examples 2, 3 and 4 where the value of V/H was 1.1 or more, the stress applied to the panel was diminished so much that possible explosion thereof due to the stress application can be prevented.

**[0070]** As described above, the panel 24 is structured to be adapted to the structure of the mask 36 of the color selection apparatus 34. That is, the third thickness Tv of the panel at the ends of the effective screen in the short axis direction is established to be larger than the third thickness Th thereof in the long axis direction, while the value of V/H is established to be 1.1 or more. In this

way, possible explosion of the panel due to the stress application can be prevented.

**[0071]** Furthermore, in the above structure, the panel bears reduced weight so that the total weight of the resulting cathode ray tube can be decreased. This can be discriminated from Table 2.

**[0072]** Table 2

| | Direction of tension application to mask | Central thickness of panel (Tc) | Stress (Long side of panel) | Weight of panel |
|---|---|---|---|---|
| Prior art | Short axis | 13.5 | 84.3 kgf/cm$^2$ | 11.18 kg |
| Present invention | Long axis | 12.3 | 84.1 kgf/cm$^2$ | 10.6 kg |

**[0073]** As described above, with the inventive cathode ray tube, mis-landing of the electron beams due to the terrestrial magnetism can be reduced while preventing occurrence of color spots. Furthermore, possible explosion of the flat panel due to the stress application can be prevented.

**[0074]** While the present invention has been illustrated by the description of embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Therefore, the invention in its aspects is not limited to the specific details, representative apparatus and method, and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of the applicant's general inventive concept.